

CLAIMS

We claim:

1. An apparatus for inclusion in a station of a wireless network, the apparatus comprising:
 - a radio receiver to wirelessly receive data from at least one remote station, said data transmitted by the remote station as at least one packet of data, the receiver including an analog-to-digital converter producing samples of signals received at the station from the remote station;
 - a demodulator coupled to the radio receiver to demodulate samples of the signals received at the receiver from each station to produce demodulated signals from each of the remote stations;
 - a signal quality calculator coupled to the receiver to determine for each remote station from which data is received a measure of the received signal quality based on the samples of the received data from the remote station; and
 - a transmitter to transmit data for transmission,
 such that in the case that the received data is ascertained include a request management message, the station responds to the request management message with a response management that include a measure of the EVM of received data corresponding to request management message,

 whereby the remote station receiving the response management message receives an indication of the quality of the link between the station and the remote station without said receiving remote station necessarily being EVM-capable.
2. An apparatus as recited in claim 1, wherein the request management message is an association or reassociation request MAC frame, and wherein the response management message that includes the measure of the EVM is an association or reassociation response frame MAC frame.

3. An apparatus as recited in claim 1, wherein the request management message is a probe request MAC frame, and wherein the response management message that includes the measure of the EVM is a probe response MAC frame.
4. An apparatus as recited in claim 1, wherein the request management message is a measurement request MAC frame, and wherein the response management message that includes the measure of the EVM is a measurement response frame MAC frame.
5. An apparatus as recited in claim 1, wherein the wireless network substantially conforms to the IEEE 802.11 wireless networking standard, and wherein the request management message and the response management message are MAC frames.
6. An apparatus for inclusion in a station of a wireless network, the apparatus comprising:
 - a radio receiver to wirelessly receive data from at least one remote station, said data transmitted by the remote station as at least one packet of data, the receiver including an analog-to-digital converter producing samples of signals received at the station from the remote station;
 - a demodulator coupled to the radio receiver to demodulate samples of the signals received at the receiver from each station to produce demodulated signals from each of the remote stations;
 - a signal quality calculator coupled to the receiver to determine for each remote station from which data is received a measure of the received signal quality based on the samples of the received data from the remote station, and
 - a transmitter to transmit data for transmission,
 wherein a message to a particular remote station in response to the data received from the particular remote station includes a measure of the EVM of the data received from the particular remote station.
7. An apparatus as recited in claim 6, wherein the wireless network substantially conforms to a wireless networking standard, and wherein a packet according to the

wireless networking standard includes a header having a first field modulated at a known rate, and wherein the message to the particular station includes the measure of the EVM in the first field.

8. An apparatus as recited in claim 7, wherein the wireless networking standard is one of the OFDM variants of the IEEE 802.11 standard.

9. An apparatus for inclusion in a station of a wireless network, the apparatus comprising:

a radio receiver to wirelessly receive data from at least one remote station, said data transmitted by the remote station as at least one packet of data, the receiver including an analog-to-digital converter producing samples of signals received at the station from the remote station;

a demodulator coupled to the radio receiver to demodulate samples of the signals received at the receiver from each station to produce demodulated signals from each of the remote stations; and

a signal quality calculator coupled to the receiver to determine for each remote station from which data is received a measure of the received signal quality based on the samples of the received data from the remote station,

such that, the receiving station selects one of the remote stations for communication according to a set of at least one criterion, said set including the respective received signal quality measure determined by the signal quality calculator for data from each of the respective remote stations.

10. An apparatus as recited in claim 9, wherein at least some of the remote stations are access points, and wherein the receiving station selects one of the access points for association according to a set of at least one criterion, said set including the respective received signal quality measure determined by the signal quality calculator for data from each of the respective access points.

11. An apparatus as recited in claim 9, wherein the network substantially conforms to one of the IEEE 802.11 standards.
12. An apparatus as recited in claim 9, wherein the signal quality calculator is an EVM calculator to determine for each remote station from which data is received a measure of the EVM of the received data from the remote station, the EVM based on samples approximately at decision points of the demodulator.
13. An apparatus as recited in claim 12, wherein at least some of the stations from which data is received are access points, and wherein the data received from remote stations that are access points are beacons or probe responses, such that one of the criteria for the station to select a remote access point for association is a measure of the EVM of a beacon or probe response received from the access point.
14. An apparatus as recited in claim 12, wherein one of the remote stations is an access point with which the station is associated, such that the station decides whether or not to roam according to the measure of signal quality from data received from the remote access point with which the station is associated.
15. An apparatus as recited in claim 13, wherein the EVM of a beacon or a probe response received from the access point is used to determine the maximum transmission rate that the link can support between the station and the remote access points, and wherein the determined maximum supported transmission rate is one of the criteria for the station to select a remote access point for association.
16. An apparatus as recited in claim 9, further comprising:
 - a transmitter to transmit data for transmission to at least one remote station,wherein in the case that the received data is ascertained to be a probe request, an association request or a reassociation request, a packet for transmission by the transmitter from the station to a particular remote station that sent the request includes a measure of the received signal quality of the request received from the particular remote station.

17. An apparatus as recited in claim 16, wherein the station ascertaining whether the received data is a probe request is an access point.
18. An apparatus as recited in claim 16, wherein the station ascertaining whether the received data is a probe request is a candidate for communication on an ad-hoc basis.
19. An apparatus as recited in claim 16, wherein the transmitter has a settable data rate, the data rate set according to a data rate signal accepted by the transmitter, said apparatus further comprising:

a data rate setting processor coupled to the signal quality calculator and to the transmitter and producing the data rate signal for the transmitter, the data rate signal set such the data rate for transmission to a particular remote station is dependent on the measure of the signal quality produced by the signal quality calculator from signals received from the particular remote station.
20. An apparatus as recited in claim 19, wherein the measure of signal quality is a measure of the EVM of the received packet, the EVM based on samples approximately at decision points of the demodulator.
21. An apparatus as recited in claim 20, wherein the data rate processor is part of a MAC layer processor for the station.
22. An apparatus as recited in claim 20, wherein the data rate processor includes a memory to store for each remote station from which data was received the measure of EVM of the last packet received from the remote station, and a running average of the measure of EVM of a number of packets last received from the remote station.
23. An apparatus as recited in claim 9, wherein the packets of data are OFDM packets, and wherein the demodulator is coupled to the receiver via a discrete Fourier transformer that produces modulated sub-carrier signals of packets received from the remote station, such that the demodulation is of the modulated sub-carrier signals.
24. An apparatus as recited in claim 12, wherein the determining of the measure of the EVM of the received packet includes determining a result of a function of the average of

the squared Euclidian distance on the I,Q plane between decision-point samples of the signal received and the nearest ideal constellation points to the decision points samples.

25. An apparatus as recited in claim 12, wherein the EVM calculator is coupled to the demodulator and wherein determining of the measure of the EVM of the received packet includes determining a result of a function of the average of the squared Euclidian distance on the I,Q plane between decision-point samples of the signal received and the correct ideal constellation points for the signal as determined by demodulating the signal.
26. An apparatus for inclusion in a station of a wireless network, the apparatus comprising:
- a radio receiver to wirelessly receive data from a remote station, said data transmitted by the remote station as at least one packet of data, the receiver including an analog-to-digital converter producing samples of signals received at the station from the remote station;
 - a demodulator coupled to the receiver to demodulate samples of the signals received at the receiver to produce demodulated signals, the samples at decision points;
 - a transmitter to transmit data for transmission to the remote station, the transmitter having a settable data rate, the data rate set according to a data rate signal accepted by the transmitter; and
 - a data rate setting processor coupled to the demodulator and to the transmitter and producing the data rate signal for the transmitter,
- the data rate signal set such that in the case that a packet received at the station from a particular remote station includes an EVM measure of the signal quality of a signal transmitted by the station and received at the particular remote station, the data rate for transmission to the particular remote station is dependent on the included EVM measure of the received signal quality.

27. An apparatus as recited in claim 26, wherein the packet that includes the EVM measure of the signal quality is a MAC layer data unit.
28. An apparatus as recited in claim 26, wherein the network substantially conforms to one of the IEEE 802.11 standards.
29. A method in a station of a wireless network, the method comprising:
 - wirelessly receiving data from at least one remote station, said data transmitted by the remote station as at least one packet of data;
 - sampling the received data corresponding to the received packet to form data samples;
 - demodulating the data samples;
 - determining a measure of signal quality from the samples of the received data; and
 - selecting one of the remote stations for communication according to a set of least one criteria including the respective determined received signal quality measure for data from each of the remote stations.
30. A method as recited in claim 29, wherein, in the case that at least some of the remote stations are access points, the selecting includes selecting one of the access points for association according to a set of least one criteria including the respective determined received signal quality measure for data from each of the access points.
31. A method as recited in claim 29, wherein the selecting selects one of the remote stations for communication on an ad-hoc basis.
32. A method as recited in claim 29, wherein the determining of the measure of signal quality includes determining a measure of the EVM of the received data from received samples approximately at the decision points for demodulating the data.
33. A method as recited in claim 32, further comprising:

selecting the data rate for communicating with the selected remote station according to at least the determined measure of the EVM.

34. A method as recited in claim 32, further comprising:
- in the case that the received data is ascertained to be a probe request or an association request for association or re-association, transmitting a packet to the particular remote station that sent the probe request or association request, the packet including an indication of the determined measure of the EVM of the packet received from the particular remote station.
35. A method as recited in claim 34, wherein the station is an access point.
36. A method as recited in claim 34, wherein the received data is ascertained to be a probe request and wherein the selecting is for ad-hoc communication.
37. An apparatus as recited in claim 32, wherein one of the remote stations is an access point with which the station is associated, such that selecting one of the access points for association includes deciding whether or not to roam according to the measure of signal quality from data received from the remote access point with which the station is associated.
38. A method as recited in claim 29, wherein the wireless network substantially conforms to one of the IEEE 802.11 standards or a derivative thereof.
39. A method as recited in claim 29, wherein the received packet is an OFDM packet.
40. A method as recited in claim 32, wherein the determining of the measure of the EVM of the received packet includes determining the average of the squared Euclidian distance on the I,Q plane between decision-point samples of the signal received and the nearest ideal constellation points to the decision point samples.
41. A method as recited in claim 32, wherein the determining of the measure of the EVM of the received packet includes determining the average of the squared Euclidian distance on the I,Q plane between decision-point samples of the signal received and the correct ideal constellation points for the signal as determined by demodulating the signal.

42. A method as recited in claim 32, wherein the selecting of the access point for association for is according to the determined signal quality and at least one other metric.
43. A method as recited in claim 42, wherein the at least one other metric includes the packet error rate (PER) for packets from the remote station.
44. A method as recited in claim 33, wherein the selecting the data rate for communicating to the remote station is according to the determined signal quality and at least one other metric.
45. A method as recited in claim 44, wherein the at least one other metric includes the packet error rate (PER) for packets from the remote station.
46. A method in a station of a wireless network, the method comprising:
- wirelessly transmitting a request management message;
 - wirelessly receiving data from at least one remote station, said data transmitted by the remote station as at least one packet of data;
 - sampling the received data corresponding to the received packet to form data samples;
 - demodulating the data samples;
 - ascertaining if the received data includes a response management message transmitted in response to a request management message; and
 - if it is ascertained that the received data includes the response management message, ascertaining if a packet has been received from the particular remote station that transmitted the response management message indicating a measure of the signal quality of the data remotely received at the particular remote station corresponding to the transmitted request management message,
- such that the message indicating the measure of signal quality can be used as an indication of the quality of communication achievable between the station and the particular remote station.

47. A method as recited in claim 46, further comprising:
- if it is ascertained that such a packet has been received from the particular remote station, selecting whether or not to associate with the particular remote station according to at least the measure of the signal quality of the remotely received data.
48. A method as recited in claim 47, wherein the determining of the measure of signal quality includes determining a measure of the EVM of the received data from received samples approximately at the decision points for demodulating the data.
49. A method as recited in claim 48, further comprising:
- selecting the data rate for communicating with the remote station according to at least the determined measure of the EVM.
50. A method as recited in claim 48, wherein the request management MAC frame is an association or reassociation request frame, and wherein the response management MAC frame that includes the measure of the DVM is an association or reassociation response frame.
51. A method as recited in claim 48, wherein the request management MAC frame is a probe request frame, and wherein the response management MAC frame that includes the measure of the DVM is a probe response frame.
52. A method as recited in claim 48, wherein the wireless network substantially conforms to the IEEE 802.11 wireless networking standard.
53. A method in a station of a wireless network, the method comprising:
- wirelessly receiving a signal from at least one remote station, said signal transmitted by the remote station as at least one packet of data;
- demodulating samples of the received signals to produce demodulated signals from each of the remote stations;

calculating a measure of the received signal quality for the signals received from the remote station using samples of the received signal from the remote stations;

ascertaining whether the received data from any remote station is a request management message; and

in the case it is ascertained that a request management message was received from a particular remote station, responding to the request management message by transmitting to the particular remote station a response management message that include a measure of the EVM of received data corresponding to request management message,

such that the particular remote station receiving the response management message receives an indication of the quality of the link between the station and the remote station without said receiving remote station necessarily being EVM-capable.

54. A method as recited in claim 53, wherein the request management message is an association or reassociation request MAC frame, and wherein the response management message that includes the measure of the EVM is an association or reassociation response MAC frame.
55. A method as recited in claim 53, wherein the request management message is a probe request MAC frame, and wherein the response management message that includes the measure of the EVM is a probe response MAC frame.
56. A method as recited in claim 53, wherein the wireless network substantially conforms to the IEEE 802.11 wireless networking standard, and wherein the request management message and the response management message are MAC frames.
57. An apparatus for a station of a wireless network, the apparatus comprising:

means for wirelessly receiving data from at least one remote station, said data transmitted by the remote station as at least one packet of data;

means for sampling the received data corresponding to the received packet to form data samples;

means for demodulating the data samples;

means for determining a measure of signal quality from the samples of the received data;

means for ascertaining whether or not at least some of the remote stations are access points, and

means for selecting one of the access points for association in the case it is ascertained that at least some of the remote stations are access points, the selecting according to a set of least one criteria including the respective determined received signal quality measure for data from each of the access points.

58. An apparatus as recited in claim 57, wherein the means for determining of the measure of signal quality includes means for determining a measure of the EVM of the received data from received samples approximately at the decision points for demodulating the data.

59. An apparatus as recited in claim 58, wherein the station is an access point, wherein the means for ascertaining whether a remote station is an access point includes means for ascertaining whether the received data includes a probe request, an association request or a reassociation request, the apparatus further comprising:

means for transmitting a packet to a remote station,

wherein in the case that the received data is ascertained to be a request, the transmitting means transmits data in response to the request that includes an indication of the determined measure of the EVM of the packet received from the particular remote station.

60. An apparatus as recited in claim 57, wherein the wireless network substantially conforms to one of the IEEE 802.11 standards or a derivative thereof.

61. An apparatus in a station of a wireless network, the apparatus comprising:

means for wirelessly transmitting a request management message;

means for wirelessly receiving data from at least one remote station, said data transmitted by the remote station as at least one packet of data;

means for sampling the received data corresponding to the received packet to form data samples;

means for demodulating the data samples;

means for ascertaining if the received data includes a response management message transmitted in response to a request management message; and

means for determining if a packet has been received from the particular remote station that transmitted the response management message indicating a measure of the signal quality of the data remotely received at the particular remote station corresponding to the transmitted request management message, the determining carried out if it is ascertained that the received data includes the response management message,

such that the message indicating the measure of signal quality can be used as an indication of the quality of communication achievable between the station and the particular remote station.

62. An apparatus as recited in claim 61, further comprising:

means for selecting whether or not to associate with the particular remote station according to at least the measure of the signal quality of the remotely received data, said selecting if it is ascertained that such a packet has been received from the particular remote station.

63. An apparatus as recited in claim 62, wherein the determining of the measure of signal quality includes determining a measure of the EVM of the received data from received samples approximately at the decision points for demodulating the data.

64. An apparatus in a station of a wireless network, the apparatus comprising:

means for wirelessly receiving a signal from at least one remote station, said signal transmitted by the remote station as at least one packet of data;

means for demodulating samples of the received signals to produce demodulated signals from each of the remote stations;

means for calculating a measure of the received signal quality for the signals received from the remote station using samples of the received signal from the remote stations;

means for ascertaining whether the received data from any remote station is a request management message;

means for transmitting; and

means for responding to the request management message in the case it is ascertained that a request management message was received from a particular remote station, the means for responding couples to the means for transmitting and transmitting to the particular remote station a response management message that include a measure of the EVM of received data corresponding to request management message,

such that the particular remote station receiving the response management message receives an indication of the quality of the link between the station and the remote station without said receiving remote station necessarily being EVM-capable.

65. An apparatus as recited in claim 64, wherein the request management message is an association or reassociation request MAC frame, and wherein the response management message that includes the measure of the EVM is an association or reassociation response MAC frame.
66. An apparatus as recited in claim 64, wherein the request management message is a probe request MAC frame, and wherein the response management message that includes the measure of the EVM is a probe response MAC frame.

67. An apparatus as recited in claim 64, wherein the wireless network substantially conforms to the IEEE 802.11 wireless networking standard.
68. A method in a wireless station, the method comprising:
- wirelessly receiving a signal from a remote station corresponding to a packet transmitted by the remote station;
 - demodulating samples of the received signal to produce demodulated signals from the remote station; and
 - selecting whether or not to associate with the remote station based on a measure of the received signal quality of data transported via the link between the station and the remote station.
69. A method as recited in claim 68, wherein the measure of the received signal quality is a measure of EVM.
70. A method as recited in claim 69, wherein the remote station is an AP, the method further comprising:
- determining at the station the measure of the received signal quality from samples of the received signal.
71. A method as recited in claim 70, wherein the transmitted packet corresponding to the received signal includes a measure of the EVM obtained from samples of signals received by the remote station corresponding to data transmitted by the station, such that the selecting uses a measure of the received signal quality of data transmitted both directions via the link between the station and the remote station.
72. A method as recited in claim 69, wherein the transmitted packet corresponding to the received signal includes the measure of the EVM obtained from samples of signals received by the remote station corresponding to data transmitted by the station.